US008215400B2

(12) **United States Patent**
Roane et al.

(10) **Patent No.: US 8,215,400 B2**
(45) **Date of Patent: Jul. 10, 2012**

(54) **SYSTEM AND METHOD FOR OPENING A WINDOW IN A CASING STRING FOR MULTILATERAL WELLBORE CONSTRUCTION**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 82 days.

(21) Appl. No.: **12/915,350**

(22) Filed: **Oct. 29, 2010**

(65) **Prior Publication Data**

US 2012/0103612 A1 May 3, 2012

(51) **Int. Cl.**
E21B 29/06 (2006.01)

(52) **U.S. Cl.** **166/313**; 166/242.7; 175/97; 175/321

(58) **Field of Classification Search** 166/50, 166/117.5, 117.6, 242.7, 313; 175/51, 77–83, 175/92, 94, 97–100, 106, 296, 297, 300, 175/305, 315, 321

See application file for complete search history.

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(57) **ABSTRACT**

A system for opening a window in a casing string (**42**) positioned in a wellbore (**32**). The system includes a hydraulic pressure intensifier (**116**) having a housing and a piston assembly with a differential piston area. The piston assembly is longitudinally shiftable relative to the housing and is initially secured relative thereto to prevent longitudinal movement therebetween. An anchor assembly (**114**) is operable to longitudinally secure the hydraulic pressure intensifier (**116**) within the casing string (**42**). A window opening tool (**118**) operably associated with the hydraulic pressure intensifier (**116**) is operably engagable with the casing string (**42**) such that when the anchor assembly (**114**) is longitudinally secured within the casing string (**42**) and the piston assembly is unsecured relative to the housing under hydrostatic pressure, longitudinal movement of the piston assembly transmits a force to the window opening tool (**118**), thereby opening the window in the casing string (**42**).

22 Claims, 9 Drawing Sheets

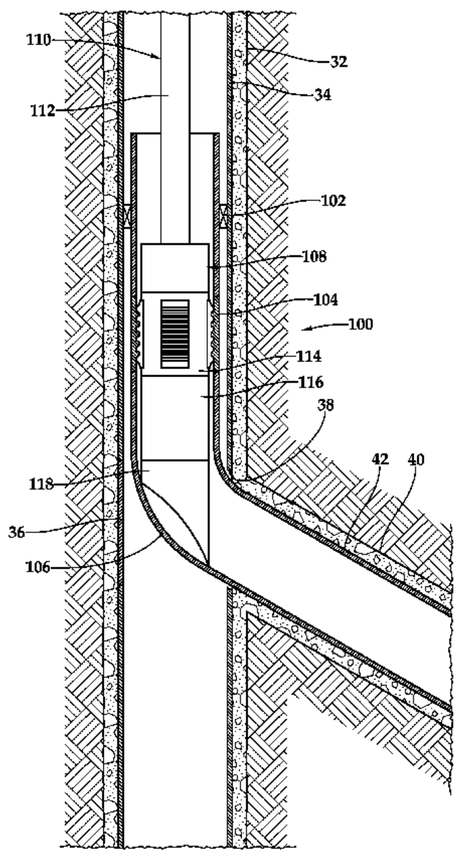
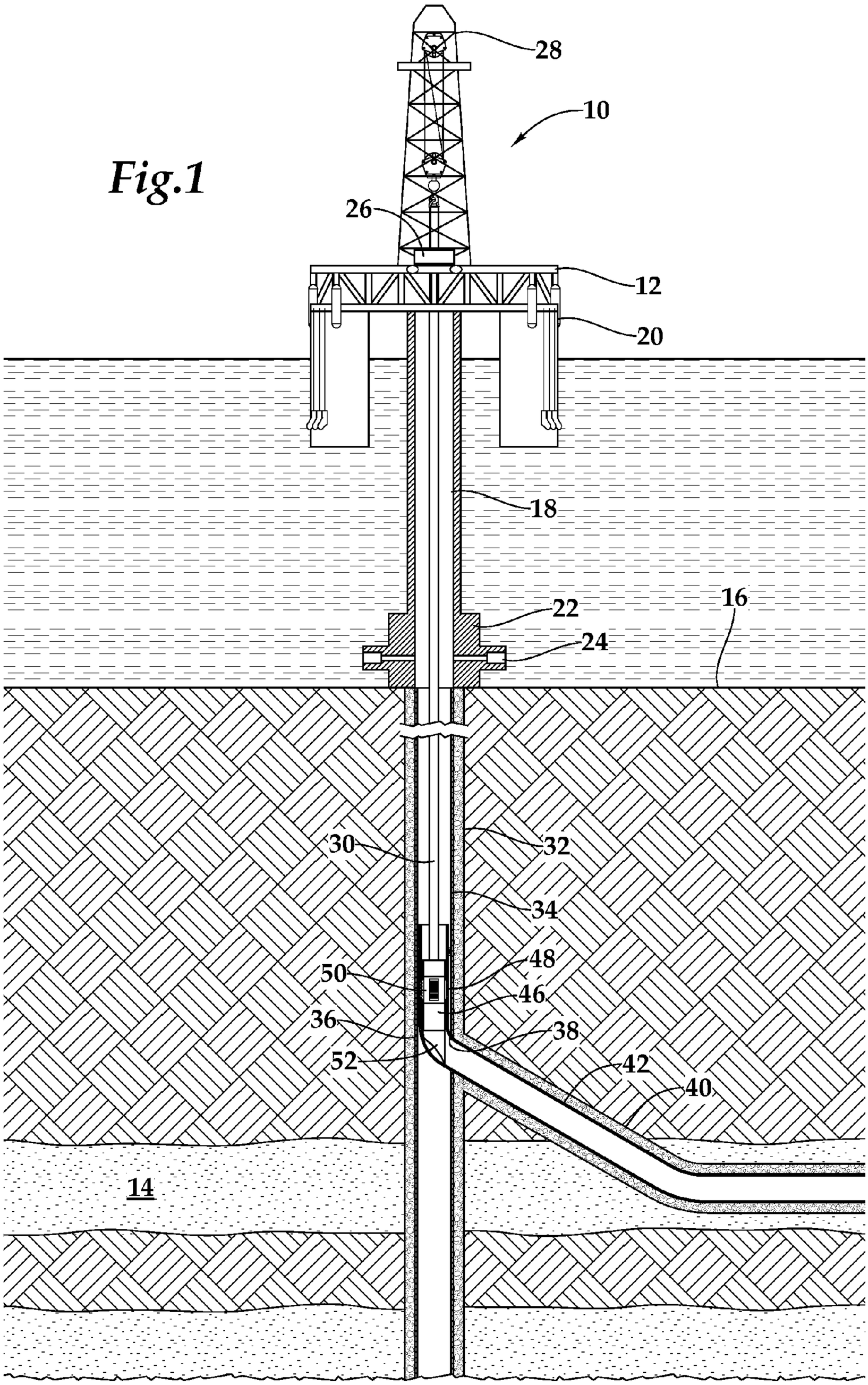


Fig.1



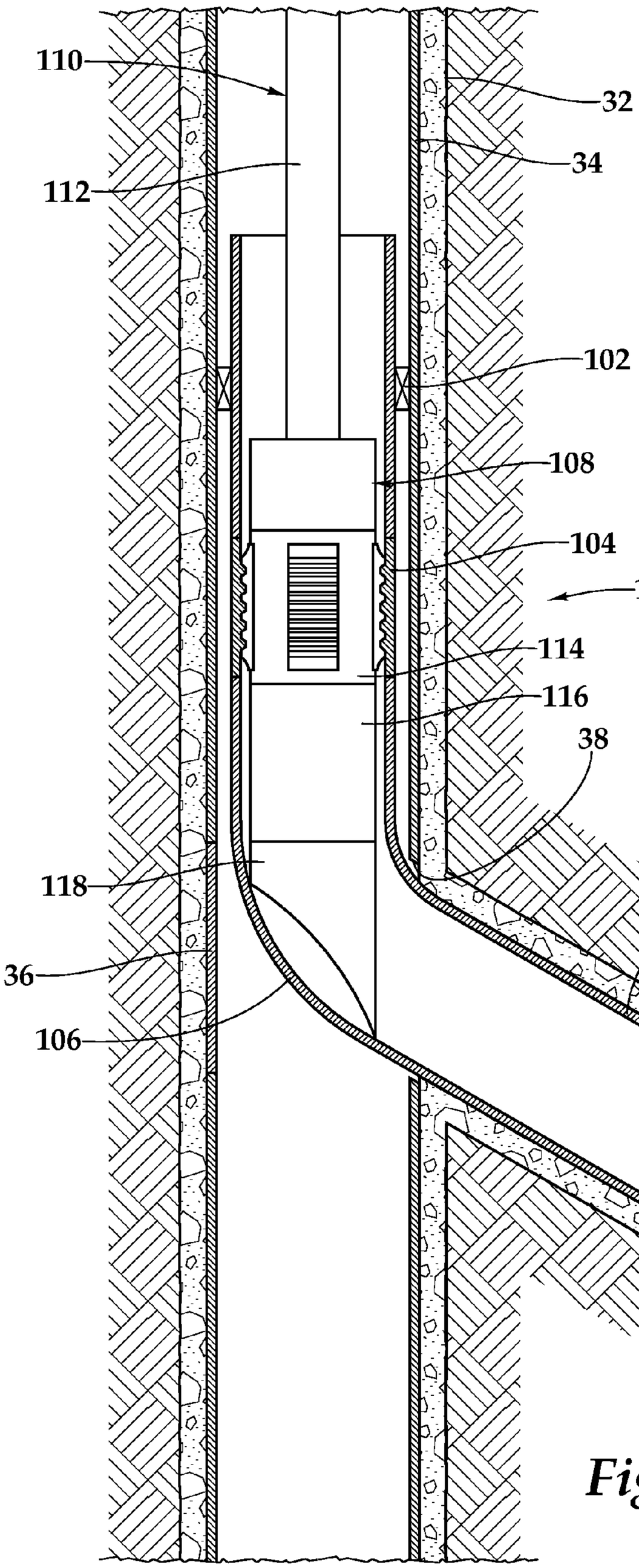


Fig.2

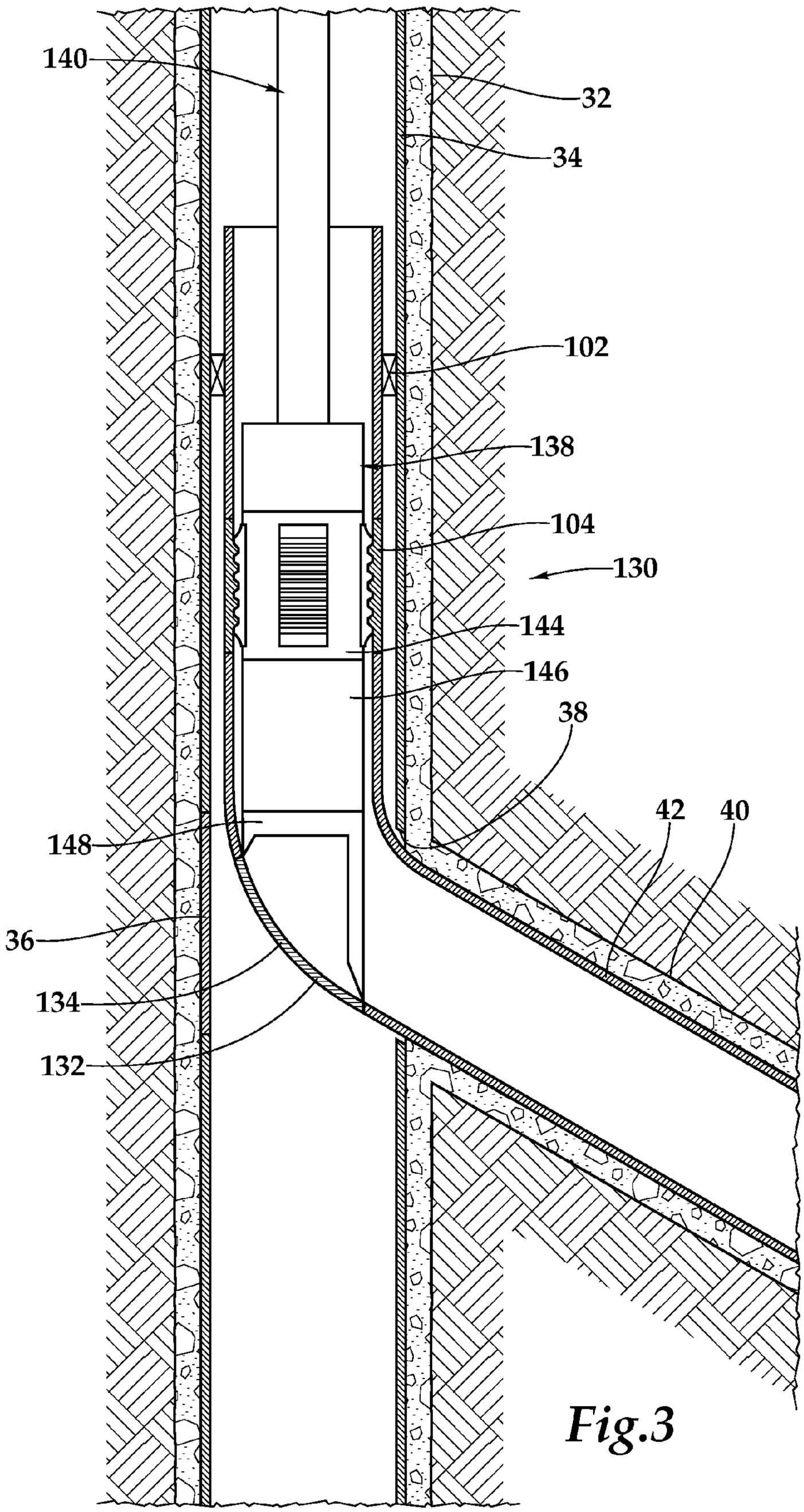


Fig.3

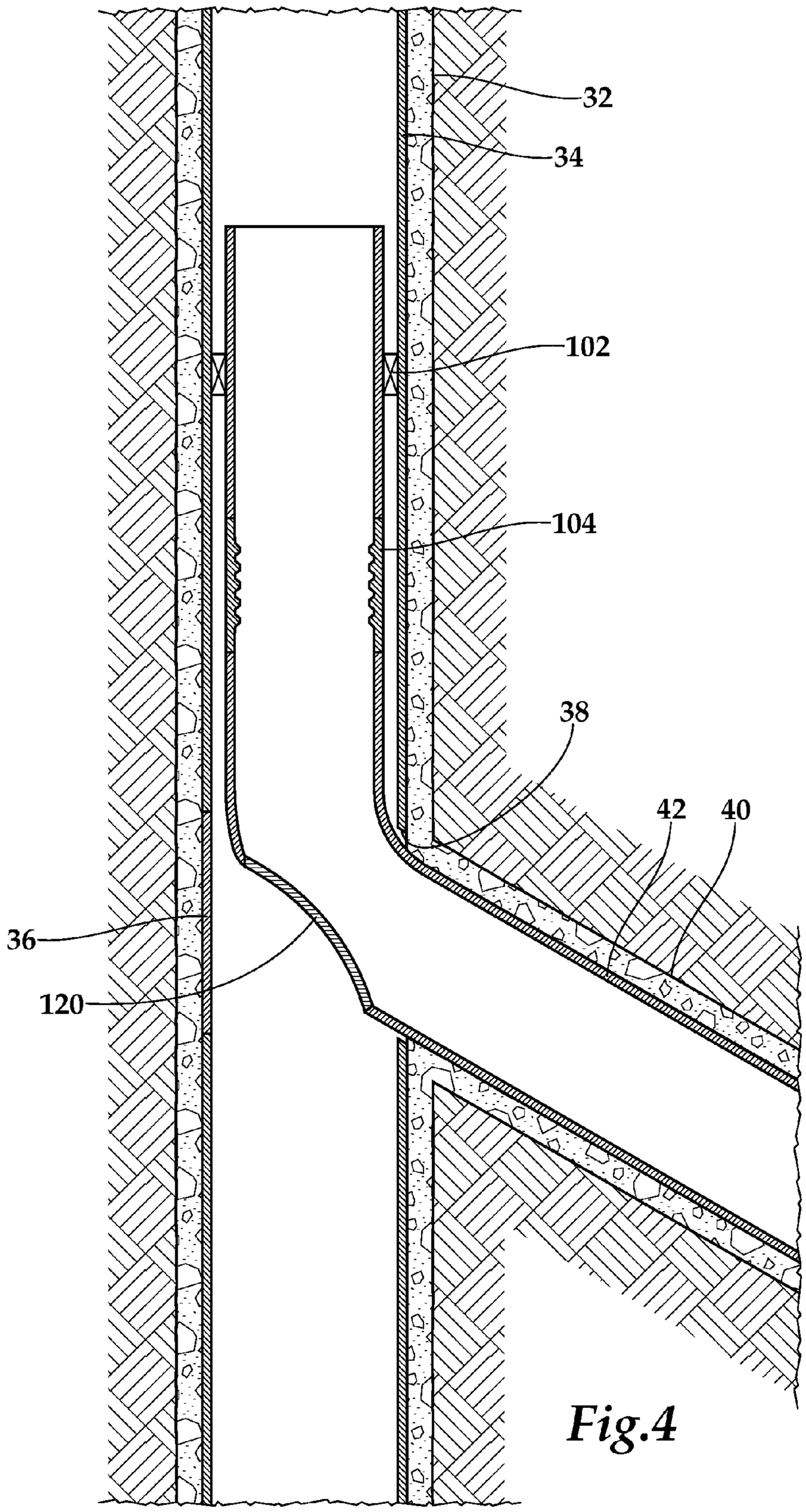


Fig.4

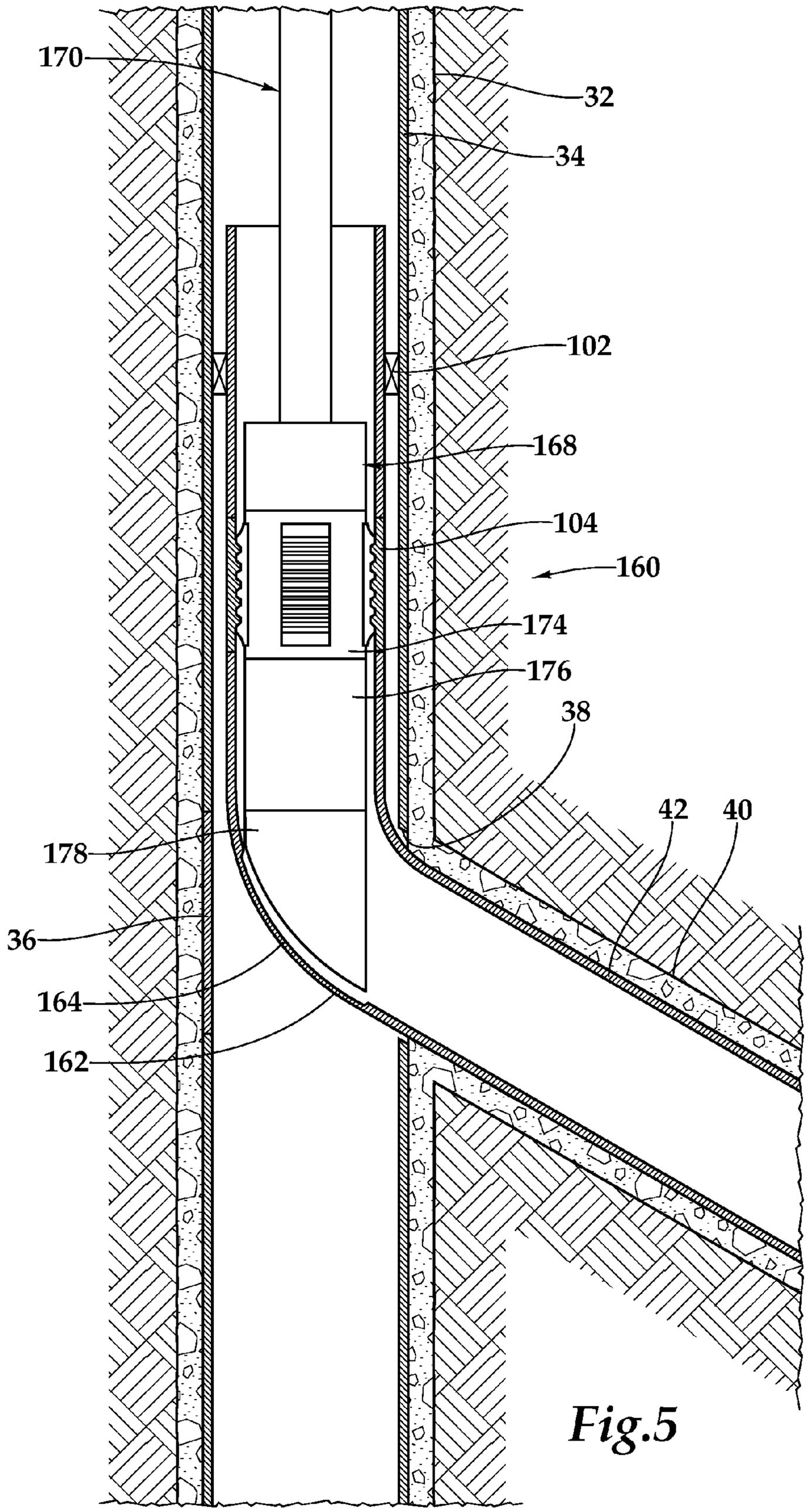


Fig.5

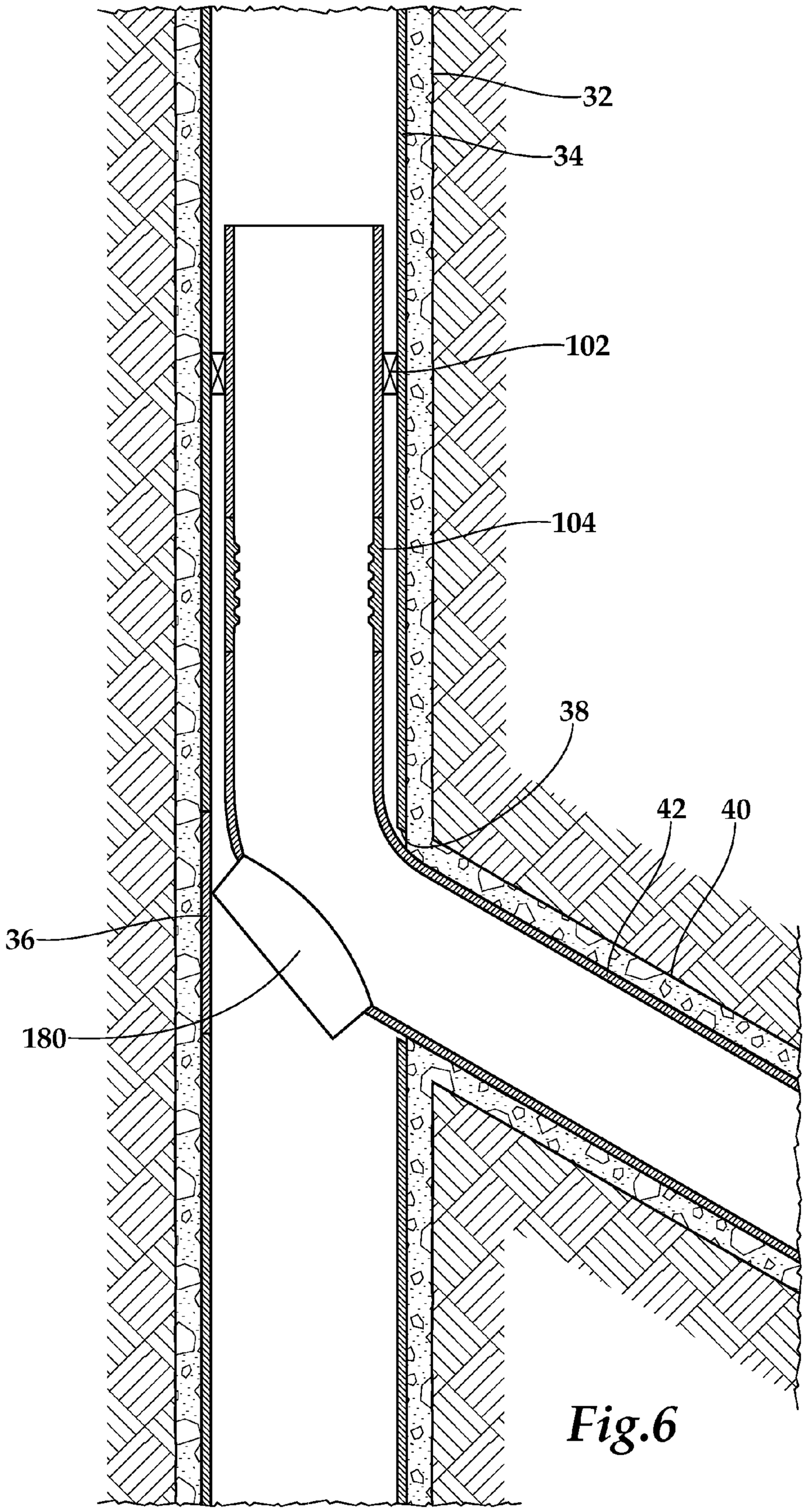


Fig.6

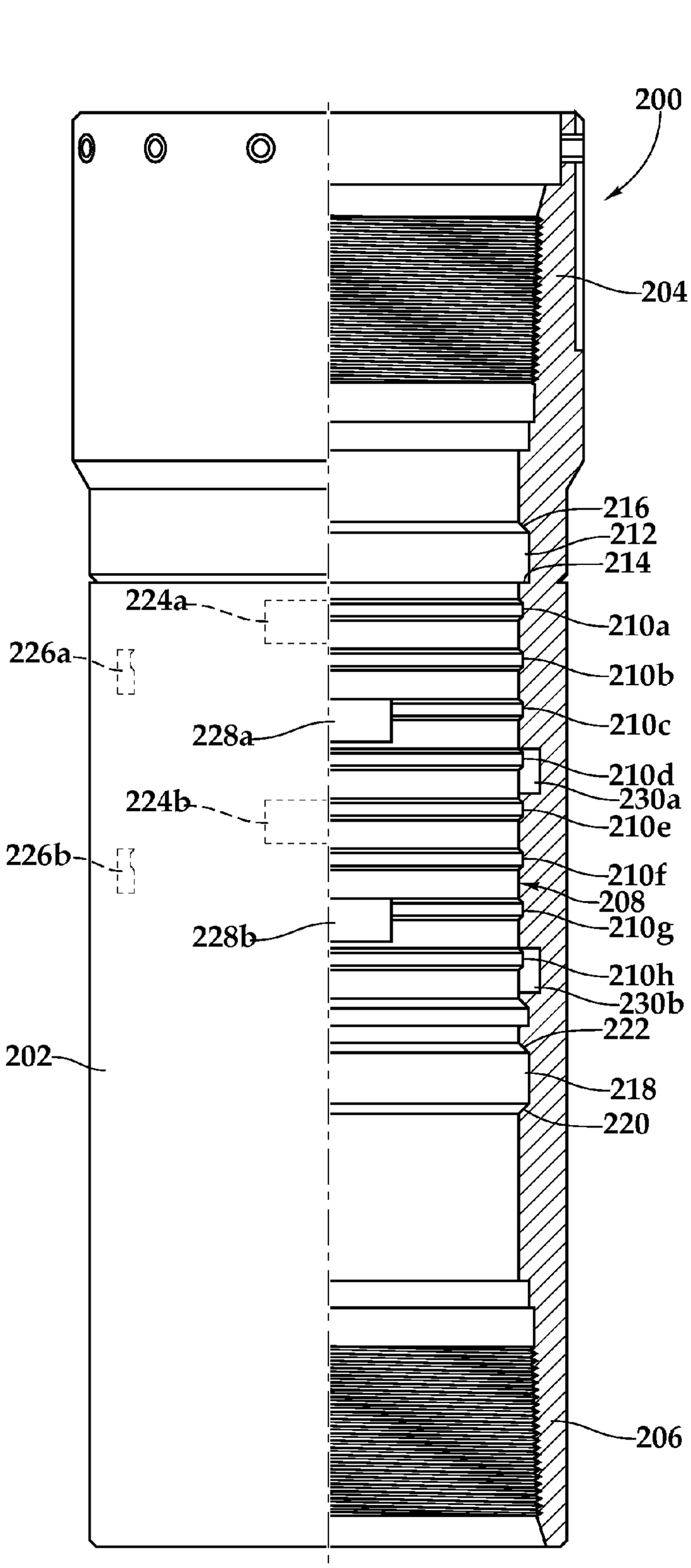
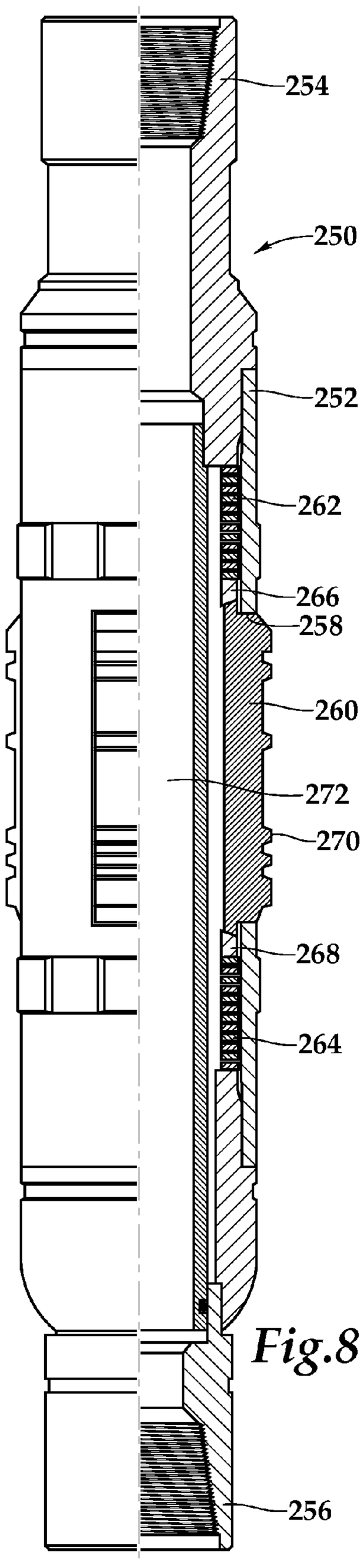

200
204
216
212
214
224a
210a
226a
210b
210c
228a
210d
224b
230a
210e
226b
210f
208
210g
228b
210h
230b
222
202
218
220
206

Fig.7


254
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262
266
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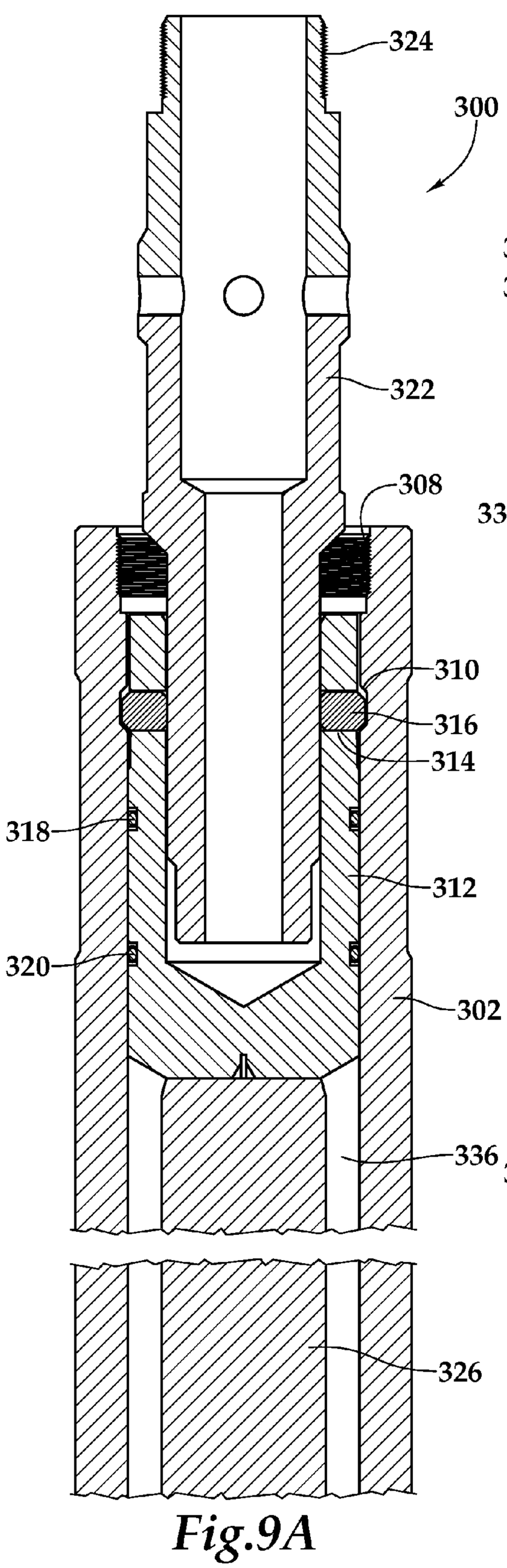
270
268
264
256

Fig.8


324
300
322
308
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316
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318
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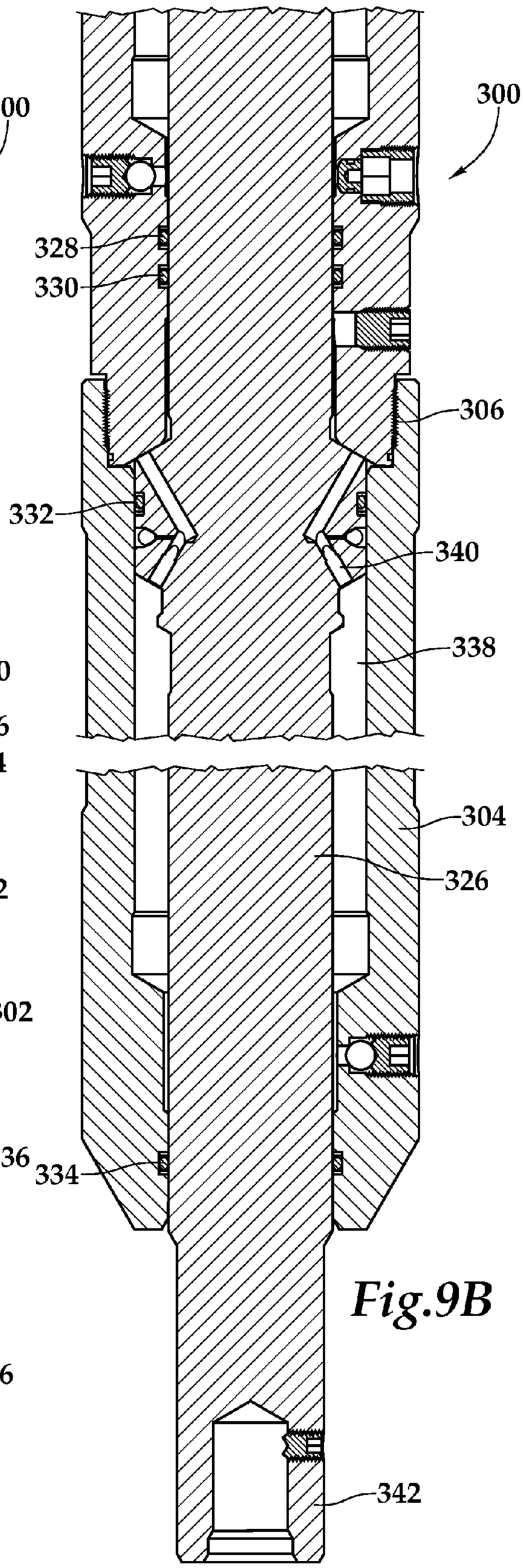
320
302
336
326

Fig.9A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328
330
306
332
340
338
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326
334
342

Fig.9B

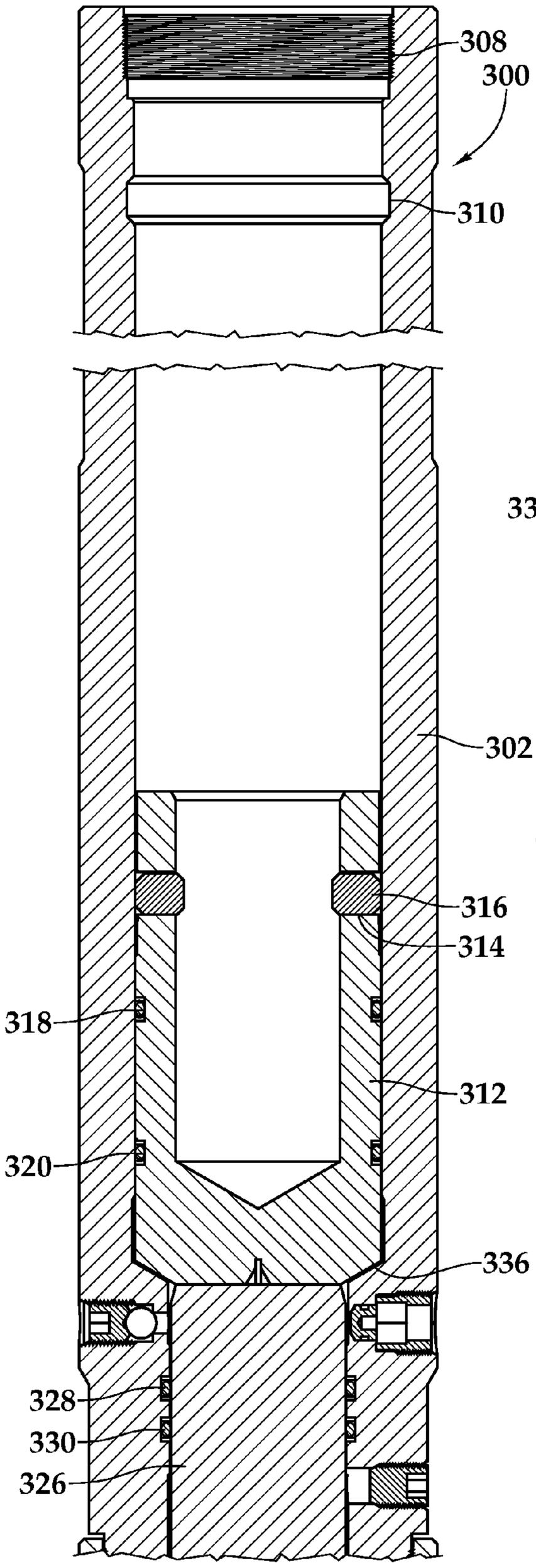

Fig.10A

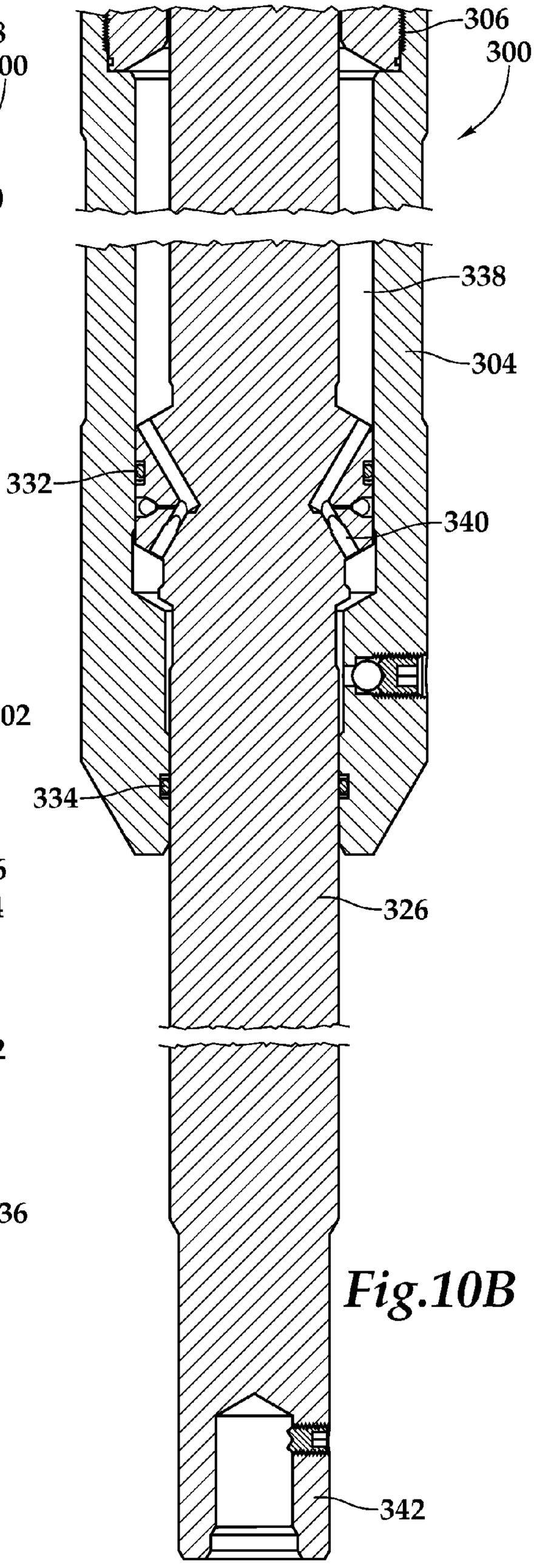

Fig.10B

SYSTEM AND METHOD FOR OPENING A WINDOW IN A CASING STRING FOR MULTILATERAL WELLBORE CONSTRUCTION

TECHNICAL FIELD OF THE INVENTION

This invention relates, in general, to equipment utilized in conjunction with operations performed in subterranean wells and, in particular, to a system and method for opening a window in a casing string for multilateral wellbore construction.

BACKGROUND OF THE INVENTION

Without limiting the scope of the present invention, its background will be described in relation to forming a window in a casing string for a multilateral well, as an example.

In multilateral wells it is common practice to drill a branch or lateral wellbore extending laterally from an intersection with a main or parent wellbore. Typically, once the casing string is installed and the parent wellbore has been completed, a whipstock is positioned in the casing string at the desired intersection and then a rotating mill is deflected laterally off of the whipstock to form a window through the casing sidewall.

Once the casing window is created, the lateral wellbore can drilled. In certain lateral wellbores, when drilling operation has been completed, a casing string is installed in the lateral branch. Casing the lateral branch may be accomplished with the installation of a liner string that is supported in the main wellbore and extends a desired distance into the lateral wellbore. Typically, once the lateral casing string is installed and the lateral wellbore has been completed, it is desirable to reestablish access to the main wellbore. In this operation, a whipstock is positioned in the casing string at the desired location and then a rotating mill is deflected off of the whipstock to form an access window through the lateral casing sidewall.

It has been found, however, that the milling process used to form the lateral window and the main wellbore access window usually produces a large amount of debris, such as small pieces of the metal casing, which accumulate in the parent wellbore. This debris may make the whipstock difficult to retrieve after the milling process is completed. In addition, even after the whipstock is retrieved, the debris may cause other problems, such as plugging flow control devices, damaging seals, obstructing seal bores, interfering with passage of equipment past the intersection and the like.

Accordingly, a need has arisen for an improved system and method of opening windows in the casing strings during multilateral wellbore construction. In addition, a need has arisen for such an improved system and method that does not require the use of a mill that generates wellbore debris during multilateral wellbore construction.

SUMMARY OF THE INVENTION

The present invention disclosed herein is directed to systems and methods of using a hydraulic pressure intensifier to generate the force required to open a window in a casing string during multilateral wellbore construction. The systems and methods of the present invention do not require the use of a mill to open the window, thereby reducing the wellbore debris generated during multilateral wellbore construction.

In one aspect, the present invention is directed to a system for opening a window in a casing string positioned in a wellbore. The system includes a hydraulic pressure intensifier having a housing and a piston assembly with a differential piston area. The piston assembly is longitudinally shiftable relative to the housing and is initially secured relative to the housing to prevent longitudinal movement therebetween. An anchor assembly is operably associated with the hydraulic pressure intensifier and is operable to longitudinally secure the hydraulic pressure intensifier within the casing string. A window opening tool operably associated with the hydraulic pressure intensifier is operably engagable with the casing string such that when the anchor assembly is longitudinally secured within the casing string and the piston assembly is unsecured relative to the housing under hydrostatic pressure in the wellbore, longitudinal movement of the piston assembly transmits a force to the window opening tool, thereby opening the window in the casing string.

In one embodiment, the casing string through which the window is opened is a main wellbore casing string. In another embodiment, the casing string through which the window is opened is a lateral wellbore casing string. In some embodiments, the piston assembly is initially secured relative to the housing by propping a plurality of lugs extending through openings of the piston assembly in a groove of the housing. In these embodiments, the piston assembly is unsecured relative to the housing by longitudinally shifting a running tool to unprop the plurality of lugs.

In one embodiment, the piston assembly includes a first piston having a first cross sectional area and a second piston operably associate with the first piston and having a second cross sectional area, wherein first cross sectional area is greater than the second cross sectional area. In certain embodiments, the piston assembly includes a dampening assembly operable to control the velocity of the longitudinal movement of the piston assembly. In some embodiments, the dampening assembly is operable to control the rate of hydraulic fluid transfer therethrough. In one embodiment, the anchor assembly may be a latch assembly that is operably engagable with a latch coupling of the casing string. In another embodiment, the window opening tool is selected from the group consisting of a cutting tool, a retrieval tool and a penetration tool.

In another aspect, the present invention is directed to a method for opening a window in a casing string positioned in a wellbore. The method includes running a hydraulic pressure intensifier having a housing and a piston assembly with a differential piston area in the casing string, the piston assembly initially secured relative to the housing to prevent longitudinal movement therebetween, positioning a window opening tool operably associated with the hydraulic pressure intensifier at a target location in the casing string, longitudinally securing the hydraulic pressure intensifier within the casing string with an anchor assembly, unsecuring the piston assembly relative to the housing under hydrostatic pressure in the wellbore and longitudinally moving the piston assembly to transmit a force to the window opening tool, thereby opening the window in the casing string.

The method may also include running the hydraulic pressure intensifier into a main wellbore casing string, running the hydraulic pressure intensifier into a lateral wellbore casing string, radially propping a plurality of lugs extending through openings of the piston assembly in a groove of the housing to initially secure the piston assembly relative to the housing, longitudinally shifting a running tool to unprop the plurality of lugs, controlling the velocity of the longitudinal movement of the piston assembly with a dampening assembly of the piston assembly, controlling the rate of hydraulic fluid transfer through the damping assembly, engaging a latch assembly

with a latch coupling of the casing string, cutting the window in the casing string, removing a window insert from the casing string or penetrating the casing string to open a pre-cut window in the casing string.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the features and advantages of the present invention, reference is now made to the detailed description of the invention along with the accompanying figures in which corresponding numerals in the different figures refer to corresponding parts and in which:

FIG. **1** is a schematic illustration of an offshore platform operating a hydraulic pressure intensifier operable to open a window in a casing string during multilateral wellbore construction according to an embodiment of the present invention;

FIG. **2** is a schematic illustration of a hydraulic pressure intensifier operable to open a window in a casing string during multilateral wellbore construction according to an embodiment of the present invention;

FIG. **3** is a schematic illustration of a hydraulic pressure intensifier operable to open a window in a casing string during multilateral wellbore construction according to an embodiment of the present invention;

FIG. **4** is a schematic illustration of a multilateral junction formed according to an embodiment of the present invention;

FIG. **5** is a schematic illustration of a hydraulic pressure intensifier operable to open a window in a casing string during multilateral wellbore construction according to an embodiment of the present invention;

FIG. **6** is a schematic illustration of a multilateral junction formed according to an embodiment of the present invention;

FIG. **7** is a quarter sectional view of a latch coupling for use with a hydraulic pressure intensifier operable to open a window in a casing string during multilateral wellbore construction according to an embodiment of the present invention;

FIG. **8** is a quarter sectional view of a latch assembly for use with a hydraulic pressure intensifier operable to open a window in a casing string during multilateral wellbore construction according to an embodiment of the present invention;

FIGS. **9**A-**9**B are cross sectional views of a hydraulic pressure intensifier operable to open a window in a casing string during multilateral wellbore construction according to an embodiment of the present invention in a first operational configuration; and

FIGS. **10**A-**10**B are cross sectional views of a hydraulic pressure intensifier operable to open a window in a casing string during multilateral wellbore construction according to an embodiment of the present invention in a second operational configuration.

DETAILED DESCRIPTION OF THE INVENTION

While the making and using of various embodiments of the present invention are discussed in detail below, it should be appreciated that the present invention provides many applicable inventive concepts which can be embodied in a wide variety of specific contexts. The specific embodiments discussed herein are merely illustrative of specific ways to make and use the invention, and do not delimit the scope of the present invention.

Referring to FIG. **1**, a hydraulic pressure intensifier operable to open a window in a casing string during multilateral wellbore construction in use with an offshore oil and gas platform is schematically illustrated and generally designated **10**. A semi-submersible platform is centered over submerged oil and gas formation **14** located below sea floor **16**. A subsea conduit **18** extends from deck **20** of platform **12** to wellhead installation **22**, including blowout preventers **24**. Platform **12** has a hoisting apparatus **26** and a derrick **28** for raising and lowering pipe strings such as drill string **30**. A main wellbore **32** has been drilled through the various earth strata including formation **14**. The terms "parent" and "main" wellbore are used herein to designate a wellbore from which another wellbore is drilled. It is to be noted, however, that a parent or main wellbore does not necessarily extend directly to the earth's surface, but could instead be a branch of yet another wellbore. A casing string **34** is cemented within main wellbore **32**. The term "casing" is used herein to designate a tubular string used to line a wellbore. Casing may actually be of the type known to those skilled in the art as "liner" and may be made of any material, such as steel or composite material and may be segmented or continuous, such as coiled tubing.

The casing string **34** includes a window joint **36** interconnected therein through which a window **38** has been opened. As illustrated, a branch or lateral wellbore **40** has been drilled through window **38** from main wellbore **32**. The terms "branch" and "lateral" wellbore are used herein to designate a wellbore which is drilled outwardly from its intersection with another wellbore, such as a parent or main wellbore. A branch or lateral wellbore may have another branch or lateral wellbore drilled outwardly therefrom. A casing string **42** in the form of a liner has been installed in lateral wellbore **40**. The upper portion of liner string **42** is supported within casing string **34** in main wellbore **32**.

To gain access to main wellbore **32** below the illustrated multilateral junction, an access window must be formed through liner string **42**. As explained in greater detail below, a hydraulic pressure intensifier **46** is secured in liner string **42** by an anchor assembly depicted as a latch coupling **48** that is operably engaged with a latch assembly **50** interconnected within liner string **42**. Thereafter, operation of hydraulic pressure intensifier **46** causes window opening tool **52** for form a window in liner string **42**.

Even though FIG. **1** depicts the present invention in a vertical section of the main wellbore, it should be understood by those skilled in the art that the system of the present invention is equally well suited for use in wellbores having other directional configurations including horizontal wellbores, deviated wellbores, slanted wells, lateral wells and the like. Accordingly, it should be understood by those skilled in the art that the use of directional terms such as above, below, upper, lower, upward, downward, uphole, downhole and the like are used in relation to the illustrative embodiments as they are depicted in the figures, the upward direction being toward the top of the corresponding figure and the downward direction being toward the bottom of the corresponding figure, the uphole direction being toward the surface of the well and the downhole direction being toward the toe of the well. Also, even though FIG. **1** depicts the present invention forming a window in a lateral wellbore liner string, it should be understood by those skilled in the art that the present invention is equally well suited for use in forming a window in the main wellbore casing string.

Referring now to FIG. **2**, a system for opening a window in a casing string during multilateral wellbore construction of the present invention is schematically depicted and generally designated **100**. In the illustrated embodiment, main wellbore **32** and lateral wellbore **40** have been drilled. Main wellbore **32** has a casing string **34** cemented therein. Casing string **34** includes a window joint interconnected therein through which a window **38** has been opened. Lateral wellbore **40** has

a casing string **42** cemented therein. Casing string **42** is in the form of a liner string, the upper portion of which is supported within casing string **34** in main wellbore **32** by liner hanger **102**. Interconnected within liner string **42** is a latch coupling **104**. As explained in further detail below, latch coupling **104** preferably has a unique profile including a plurality preferential circumferential alignment elements that is operable to receive a latch assembly therein and locate the latch assembly in a particular circumferential orientation. Also interconnected within liner string **42** is a window joint **106** through which an access window can be formed.

In the illustrated embodiment, a tool string **108** has been run in liner string **42** on a conveyance **110** such as a drill string **112**. Tool string **108**, includes a latch assembly **114**, a hydraulic pressure intensifier **116** and a window opening tool depicted as a cutting tool **118**. Preferably, latch assembly **114** has a unique outer profile that is operable to engage with the unique inner profile and preferential circumferential alignment elements of latch coupling **104**. As explained in greater detail below, hydraulic pressure intensifier **116** is operable to provide work downhole in the form of a longitudinal movement with sufficient force to enable a window to be opened through a casing string or other metal tubular. Cutting tool **118** is designed to make a cut through liner string **42** responsive to the axial movement and force generated by hydraulic pressure intensifier **116**. Preferably, cutting tool **118** captures the window section that is cut from liner string such that the window section can be retrieved to the surface with tool string **108** leaving an open window **120** in liner string **42**, as best seen in FIG. **4**.

Referring now to FIG. **3**, a system for opening a window in a casing string during multilateral wellbore construction of the present invention is schematically depicted and generally designated **130**. In the illustrated embodiment, main wellbore **32** and lateral wellbore **40** have been drilled. Main wellbore **32** has a casing string **34** cemented therein. Casing string **34** includes a window joint interconnected therein through which a window **38** has been opened. Lateral wellbore **40** has a casing string **42** cemented therein. Casing string **42** is in the form of a liner string, the upper portion of which is supported within casing string **34** in main wellbore **32** by liner hanger **102**. Interconnected within liner string **42** is a latch coupling **104** that has a unique profile operable to receive a latch assembly. Also interconnected within liner string **42** is a window joint **132** that includes a pre-milled window having a window insert **134** positioned therein.

In the illustrated embodiment, a tool string **138** has been run in liner string **42** on a conveyance **140**. Tool string **138**, includes a latch assembly **144**, a hydraulic pressure intensifier **146** and a window opening tool depicted as a retrieval tool **148**. Preferably, latch assembly **144** has a unique outer profile that is operable to engage with the unique inner profile of latch coupling **104**. Hydraulic pressure intensifier **146** is operable to provide work downhole in the form of a longitudinal movement with sufficient force to enable window insert **134** to be released and removed by retrieval tool **148**. Retrieval tool **148** is designed to release and remove window insert **134** from window joint **132** responsive to the axial movement and force generated by hydraulic pressure intensifier **146**.

Preferably, retrieval tool **148** captures window insert **134** such that window insert **134** can be retrieved to the surface with tool string **138** leaving an open window **120** in liner string **42**, as best seen in FIG. **4**.

Referring now to FIG. **5**, a system for opening a window in a casing string during multilateral wellbore construction of the present invention is schematically depicted and generally designated **160**. In the illustrated embodiment, main wellbore **32** and lateral wellbore **40** have been drilled. Main wellbore **32** has a casing string **34** cemented therein. Casing string **34** includes a window joint interconnected therein through which a window **38** has been opened. Lateral wellbore **40** has a casing string **42** cemented therein. Casing string **42** is in the form of a liner string, the upper portion of which is supported within casing string **34** in main wellbore **32** by liner hanger **102**. Interconnected within liner string **42** is a latch coupling **104** that has a unique profile operable to receive a latch assembly. Also interconnected within liner string **42** is a window joint **162** that includes a window pattern **164** pre-cut therein, for example, by scoring or otherwise preferentially weakening certain areas on the inner or outer surface of window joint **162** such that window joint **162** will open in a predictable manner.

In the illustrated embodiment, a tool string **168** has been run in liner string **42** on a conveyance **170**. Tool string **168**, includes a latch assembly **174**, a hydraulic pressure intensifier **176** and a window opening tool depicted as a penetration tool **178**. Preferably, latch assembly **174** has a unique outer profile that is operable to engage with the unique inner profile of latch coupling **104**. Hydraulic pressure intensifier **176** is operable to provide work downhole in the form of a longitudinal movement with sufficient force to enable opening of the pre-cut window **164** by penetration tool **178**. Penetration tool **178** is designed to open pre-cut window **164** along its score lines without creating debris. For example, the score pattern of pre-cut window **164** may enable the window to be open by folding back two door sections such as in a bomb bay door style, leaving an open window **180** in liner string **42**, as best seen in FIG. **6**.

Referring next to FIG. **7**, one embodiment of a latch coupling operable for use with a hydraulic pressure intensifier for multilateral wellbore construction of the present invention is depicted and generally designated **200**. Latch coupling **200** is representative of latch coupling **104** depicted above; however, as discussed above, each latch coupling will have a unique inner profile and preferential circumferential alignment elements that are different from that of other latch couplings to enable selective engagement with a matching or mating outer profile of the desired latch assembly. Accordingly, latch coupling **200** is described herein to illustrate the type of elements and combination of elements that can be used to create any number of unique profiles as contemplated by the present invention.

Latch coupling **200** has a generally tubular body **202** and may be coupled to other tools or tubulars such as liner string **42** via threaded connections **204**, **206**. Latch coupling **200** includes an internal profile **208** including a plurality of axially spaced apart recessed grooves **210***a*-**210***h* that extend circumferentially about the inner surface of latch coupling **200**. Preferably, recessed grooves **210***a*-**210***h* extend about the entire circumferential internal surface of latch coupling **200**. Internal profile **208** also includes an upper groove **212** having a lower square shoulder **214** and an upper angled shoulder **216**. Internal profile **208** further includes a lower groove **218** having a lower angled shoulder **220** and an upper angled shoulder **222**.

Internal profile **208** also has a plurality of preferential circumferential alignment elements depicted as a plurality of slots disposed within the inner surface of latch coupling **200**. In the illustrated embodiment, there are four sets of two slots that are disposed in different axial and circumferential positions or locations within the inner surface of latch coupling **200**. For example, a first set of two slots or recesses **224***a*, **224***b* (collectively recesses **224**) are disposed within the inner surface of latch coupling **200** at substantially the same cir-

cumferential positions and different axial positions. A second set of two slots or recesses **226***a*, **226***b* (collectively recesses **226**) are disposed within the inner surface of latch coupling **200** at substantially the same circumferential positions and different axial positions. A third set of two slots or recesses **228***a*, **228***b* (collectively recesses **228**) are disposed within the inner surface of latch coupling **200** at substantially the same circumferential positions and different axial positions. A fourth set of two slots or recesses **230***a*, **230***b* (collectively recesses **230**) are disposed within the inner surface of latch coupling **200** at substantially the same circumferential positions and different axial positions.

As shown, recesses **226** are disposed within the inner surface of latch coupling **200** at a ninety degree angle circumferentially from recesses **224**. Likewise, recesses **228** are disposed within the inner surface of latch coupling **200** at a ninety degree angle circumferentially from recesses **226**. Finally, recesses **230** are disposed within the inner surface of latch coupling **200** at a ninety degree angle circumferentially from recesses **228**. Preferably, recesses **224**, **226**, **228**, **230** only partially extend circumferentially about the internal surface of latch coupling **200**.

Profile **208** including the preferential circumferential alignment elements creates a unique mating pattern operable to cooperate with an external key profile associated with a desired latch assembly to axially and circumferentially anchor and orient a window opening tool in a particular desired circumferential orientation relative to the window joint of the casing string. The specific profile of each latch coupling can be created by varying one or more of the elements or parameters thereof. For example, the thickness, number and relative spacing of the recessed grooves can be altered, the axial and circumferential spacing of the preferential circumferential alignment elements can be altered, the axial and circumferential thickness of the preferential circumferential alignment elements can be altered, the number of preferential circumferential alignment elements can be altered and the like.

Referring next to FIG. **8**, an anchor assembly depicted as a latch assembly operable for use with a hydraulic pressure intensifier for multilateral wellbore construction of the present invention is depicted and generally designated **250**. Latch assembly **250** includes a latch housing **252** may be coupled to other tools or tubulars such a hydraulic pressure intensifier via threaded connections **254**, **256**. Latch housing **252** has a plurality of elongated openings **258** formed therethrough. A plurality of spring operated keys **260** extend through elongated openings **258**. Keys **260** are radially outwardly biased by Belleville springs **262**, **264** that urge conical wedges **266**, **268** under keys **260** from above and below. Alignment between keys **260** and openings **258** as well as appropriate spacing between keys **260** are maintained by latch housing **252**, which also limits the outward displacement keys **260**.

The anchoring and orienting functions of latch assembly **250** with a latch coupling having the appropriate mating profile are performed by engagement between external profiles **270** formed on each of the keys **260** and inner profile and preferential circumferential alignment elements formed in the latch coupling. Different profiles **270** are formed on keys **260** of latch assembly **250**, to correspond to different radial portions of the inner profile and preferential circumferential alignment elements formed in the latch coupling. When latch assembly **250** is disposed within the corresponding latch coupling, profiles **270** on keys **260** initially engage the inner profile and thereby prevent further longitudinal displacement of latch assembly **250** relative to the latch coupling. Latch assembly **250** is then rotated within the latch coupling, until each of the profiles **270** engages the corresponding preferential circumferential alignment elements formed in the latch coupling, thereby preventing further rotational displacement of latch assembly **250** relative to the latch coupling. Latch assembly **250** includes a central bore **272** which allows fluids and other tools or tubulars such as drill pipe to pass therethrough.

Referring next to FIGS. **9**A-**9**B, consecutive axial sections of a hydraulic pressure intensifier for multilateral wellbore construction of the present invention are depicted and generally designated **300**. Hydraulic pressure intensifier **300** includes an outer housing depicted as upper housing member **302** and lower housing member **304** that are threadedly and sealably coupled together at **306**. Upper housing member **302** may be coupled to other tools or tubulars such a latch assembly via threaded connection **308**. Upper housing member **302** has a radially reduced groove **310**.

Slidably positioned within upper housing member **302** is a piston **312**. Piston **312** includes a plurality of openings **314** in the sidewall portion thereof. A plurality of lugs **316** are positioned within openings **314**. A pair of seals depicted as O-rings **318**, **320** provides for a sealing engagement between piston **312** and the interior of upper housing member **302**. Slidably positioned within piston **312** is a running tool **322**. Running tool **322** may be coupled to other tools or tubulars such a drill string via threaded connection **324**. As illustrated, running tool **322** props lugs **316** into groove **310** which initially prevents relative longitudinal movement between piston **312** and upper housing member **302**. Preferably, running tool **322** is initially longitudinally secured relative to upper housing member **302** by, for example, a shear pin connection between running tool **322** or a tubular attached thereto and the latch assembly coupled to upper housing member **302**.

Positioned below piston **302** is a piston **326**. A pair of seals depicted as O-rings **328**, **330** provides for a sealing engagement between piston **326** and the interior of upper housing member **302**. A second pair of seals depicted as O-rings **332**, **334** provides for a sealing engagement between piston **326** and the interior of lower housing member **304**. Together, piston **312** and piston **326** may be referred to as a piston assembly. A low pressure or atmospheric chamber **336** is defined between piston **326** and the interior of upper housing member **302**. Atmospheric chamber **336** preferably contains a compressible fluid such as nitrogen gas. An optional hydraulic chamber **338** is defined between piston **326** and the interior of lower housing member **304**. Piston **326** includes a dampening assembly depicted as a plurality of jets **340** operable to control the rate of hydraulic fluid transfer therethrough in embodiments utilizing an operating fluid within hydraulic chamber **338**. Additionally, at its lower end, piston **326** includes a connector **342** for coupling piston **326** to other tools such as one of the window opening tools discussed above.

Preferably, hydraulic pressure intensifier **300** is operated using the hydrostatic pressure in the wellbore. Alternatively, the pressure in the wellbore can be enhanced by adding additional pressure at the surface. In either case, the operation of hydraulic pressure intensifier **300** is based upon the differential areas of piston **312** and piston **326**. In one embodiment, piston **312** may have a diameter of approximately 8 inches and piston **326** may have a diameter of approximately 2 inches. The calculated surface area of piston **312** is approximately 50.26 in^2 and the calculated surface area of piston **326** is approximately 3.14 in^2. The difference between these two surface areas is approximately 47.12 in^2. In this example, if piston **312** and piston **326** are in a pressure environment of

5,000 pounds per square inch, this pressure acting on the differential areas of piston **312** and piston **326** creates a resultant force that can be exerted by piston **326** of approximately 235,650 pounds of force. This downward force is exerted by piston **326** when running tool **322** is shifted upwardly relative to piston **312** which unprops lugs **316** allowing piston **312** and piston **326** to move longitudinally downwardly relative to upper housing member **302** and lower housing member **304**, as best seen in FIGS. **10**A-**10**B. The speed of this movement can be regulated by forcing the optional operating fluid in hydraulic chamber **338** through jets **340**. The downward movement and downward force of piston **326** operate on a window opening tool to create the desired window in a casing string.

While this invention has been described with reference to illustrative embodiments, this description is not intended to be construed in a limiting sense. Various modifications and combinations of the illustrative embodiments as well as other embodiments of the invention will be apparent to persons skilled in the art upon reference to the description. It is, therefore, intended that the appended claims encompass any such modifications or embodiments.

What is claimed is:

1. A system for opening a window in a casing string positioned in a wellbore, the system comprising:

a hydraulic pressure intensifier having a housing and a piston assembly with a differential piston area, the piston assembly longitudinally shiftable relative to the housing, the piston assembly initially secured relative to the housing to prevent longitudinal movement therebetween;

an anchor assembly operably associated with the hydraulic pressure intensifier, the anchor assembly operable to longitudinally secure the hydraulic pressure intensifier within the casing string; and

a window opening tool operably associated with the hydraulic pressure intensifier and operably engagable with the casing string such that when the anchor assembly is longitudinally secured within the casing string and the piston assembly is unsecured relative to the housing under hydrostatic pressure in the wellbore, longitudinal movement of the piston assembly transmits a force to the window opening tool, thereby opening the window in the casing string.

2. The system as recited in claim **1** wherein the casing string further comprises a main wellbore casing string.

3. The system as recited in claim **1** wherein the casing string further comprises a lateral wellbore casing string.

4. The system as recited in claim **1** wherein the piston assembly is initially secured relative to the housing via a plurality of lugs extending through openings of the piston assembly and radially propped in a groove of the housing.

5. The system as recited in claim **4** wherein the piston assembly is unsecured relative to the housing by longitudinally shifting a running tool to unprop the plurality of lugs.

6. The system as recited in claim **1** wherein the piston assembly further comprises a first piston having a first cross sectional area and a second piston operably associate with the first piston and having a second cross sectional area, the first cross sectional area being greater than the second cross sectional area.

7. The system as recited in claim **1** wherein the piston assembly further comprises a dampening assembly operable to control the velocity of the longitudinal movement of the piston assembly.

8. The system as recited in claim **7** wherein the dampening assembly is operable to control the rate of hydraulic fluid transfer therethrough.

9. The system as recited in claim **1** wherein the anchor assembly further comprises a latch assembly.

10. The system as recited in claim **1** wherein the window opening tool is selected from the group consisting of a cutting tool, a retrieval tool and a penetration tool.

11. A method for opening a window in a casing string positioned in a wellbore, the method comprising:

running a hydraulic pressure intensifier having a housing and a piston assembly with a differential piston area in the casing string, the piston assembly initially secured relative to the housing to prevent longitudinal movement therebetween;

positioning a window opening tool operably associated with the hydraulic pressure intensifier at a target location in the casing string;

longitudinally securing the hydraulic pressure intensifier within the casing string with an anchor assembly;

unsecuring the piston assembly relative to the housing under hydrostatic pressure in the wellbore; and

longitudinally moving the piston assembly to transmit a force to the window opening tool, thereby opening the window in the casing string.

12. The method as recited in claim **11** wherein running a hydraulic pressure intensifier having a housing and a piston assembly with a differential piston area in the casing string further comprises running the hydraulic pressure intensifier into a main wellbore casing string.

13. The method as recited in claim **11** wherein running a hydraulic pressure intensifier having a housing and a piston assembly with a differential piston area in the casing string further comprises running the hydraulic pressure intensifier into a lateral wellbore casing string.

14. The method as recited in claim **11** further comprising radially propping a plurality of lugs extending through openings of the piston assembly in a groove of the housing to initially secure the piston assembly relative to the housing.

15. The method as recited in claim **14** wherein unsecuring the piston assembly relative to the housing under hydrostatic pressure in the wellbore further comprises longitudinally shifting a running tool to unprop the plurality of lugs.

16. The method as recited in claim **11** wherein the piston assembly further comprises a first piston having a first cross sectional area and a second piston operably associate with the first piston and having a second cross sectional area, the first cross sectional area being greater than the second cross sectional area.

17. The method as recited in claim **11** further comprising controlling the velocity of the longitudinal movement of the piston assembly with a dampening assembly of the piston assembly.

18. The method as recited in claim **17** wherein controlling the velocity of the longitudinal movement of the piston assembly with a dampening assembly further comprises controlling the rate of hydraulic fluid transfer through the damping assembly.

19. The method as recited in claim **11** wherein longitudinally securing the hydraulic pressure intensifier within the casing string with anchor assembly further comprises engaging a latch assembly with a latch coupling of the casing string.

20. The method as recited in claim **11** wherein opening the window in the casing string further comprises cutting the window in the casing string.

21. The method as recited in claim **11** wherein opening the window in the casing string further comprises removing a window insert from the casing string.

22. The method as recited in claim **11** wherein opening the window in the casing string further comprises penetrating the casing string to open a pre-cut window in the casing string.

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